NEW RECORDS FOR *TORTOPUS INCERTUS* (EPHEMEROPTERA) IN MISSISSIPPI AND NOTES ON MICROHABITAT REQUIREMENTS[1,2]

S.S. Knight, C.M. Cooper[3]

ABSTRACT: Specimens of the burrowing mayfly *Tortopus incertus*, typically considered an inhabitant of clay banks in large rivers, were collected in Otoucalofa Creek, a small bluff line stream in Calhoun, Lafayette, and Yalobusha Counties, Mississippi. Intensive reconnaissance of major stream reaches revealed three *T. incertus* colonization sites which represent a major habitat extension and suggest that the size of the stream is less important than the hard clay substrate needed for the construction of burrows. Greater instability of physical characteristics of small streams compared to rivers also indicates tolerance of *T. incertus* to larger environmental fluctuations than previously documented.

During routine sampling of macroinvertebrates on Otoucalofa Creek, two burrowing mayflies of the family Polymitarcidae were discovered in a kick sample taken near Water Valley, Mississippi. These mayflies, identified as *Tortopus incertus* (Traver), have been described by several authors as restricted to hard clay banks of large rivers (Scott *et al.* 1959, McCafferty 1975, Edmunds *et al.* 1976, Unzicker and Carlson 1982, and Edmunds 1984). Otoucalofa Creek is a highly erosive second order stream in the bluff line hills of northern Mississippi and is currently undergoing bank stabilization modifications as a part of a Demonstration Erosion Control Project (DEC) in the Yazoo Basin. Preliminary ecological surveys described Otoucalofa Creek as a small sandy bottomed stream 27 km long. With a width ranging from 0.5 to 8 m and a base flow water depth of 0.1 to 1 m, the creek is distinctly different from the habitat previously described for *T. incertus*. In Mississippi, *T. incertus* has been collected in the Tombigbee River (Monroe County), Bull Mountain Creek at its confluence with the Tombigbee River (Itawamba County), the Leaf River (Lawrence County), the Pearl River, and Bogue Chitto (Pike County) by C.D. Hynes (Scott *et al.* 1959). This mayfly has also been commonly found in clay banks of the Mississippi River (Beckett *et al.* 1983). *T. incertus* has never been reported from small shallow streams. Since discovery of *T. incertus* in Otoucalofa Creek suggested possible new microhabitat criteria, a closer investigation of Otoucalofa

[1]Received April 13, 1987. Accepted August 6, 1988.

[2]Contribution of the Sedimentation Laboratory, Agricultural Research Service, U.S. Department of Agriculture, Oxford, MS

[3]Ecologists, U.S. Department of Agriculture, Agricultural Research Service, Sedimentation Laboratory, Oxford, Mississippi 38655.

Creek was needed to determine the extent of *T. incertus* colonization and its environmental requirements.

METHODS

Otoucalofa Creek is typical of most Mississippi bluff line streams in that it is a shallow high gradient stream with more than 95 percent of the bottom substrate consisting of sand or gravelly sand. Approximately 75 percent of the stream has been subjected to channelization within the past 30 years and about 30 percent of its length is devoid of vegetative canopy. Areas of hard clay substrate are occasionally found in the headwaters of the stream's main channel and in tributaries where the depth is usually 3 to 10 cm.

Macroinvertebrates were collected during spring and fall in 1985 and 1986 on Otoucalofa Creek and its tributaries. A general benthos survey was made to compile a list of species, population sizes and habitat preference. Sampling techniques included kick samples, grab samples, snag samples, leaf pack collections and Surber or Hess samples so that all major habitat types could be examined. After initially finding *T. incertus* in a kick sample, 15 cm by 15 cm scoop samples were also included so that hard clay areas could be sampled quantitatively. Otoucalofa Creek and its tributaries were divided into 16 sections representing stream reaches with similar characteristics such as substrate, channel depth, channel width, current or water depth. Each reach was sampled with a minimum of three techniques and at least 2 samples per technique. Physical and chemcial parameters were measured at selected sites to provide water quality data. Measurements of water depth, current and substrate type were also made at each sample site.

RESULTS AND DISCUSSION

Three areas in Otoucalofa Creek watershed supported populations of *T. incertus* (Fig. 1). These areas were all in the upper half of the watershed and had similar physical characteristics. All three habitats were composed of hard clay substrates, with a minimum flow of 30 cm/sec and a maximum baseline depth of 5 cm. These habitats are typically sites of channel degradation where unconsolidated materials have been eroded down to hard clay strata.

Water quality immediately downstream of the collection sites was typical of northern Mississippi bluff line streams (Table 1). The yearly mean pH for Otoucalofa collection sites was 6.4 with a range of 5.4 to 7.4. These mean values were lower than 6.8, the established lower limit for *T.*

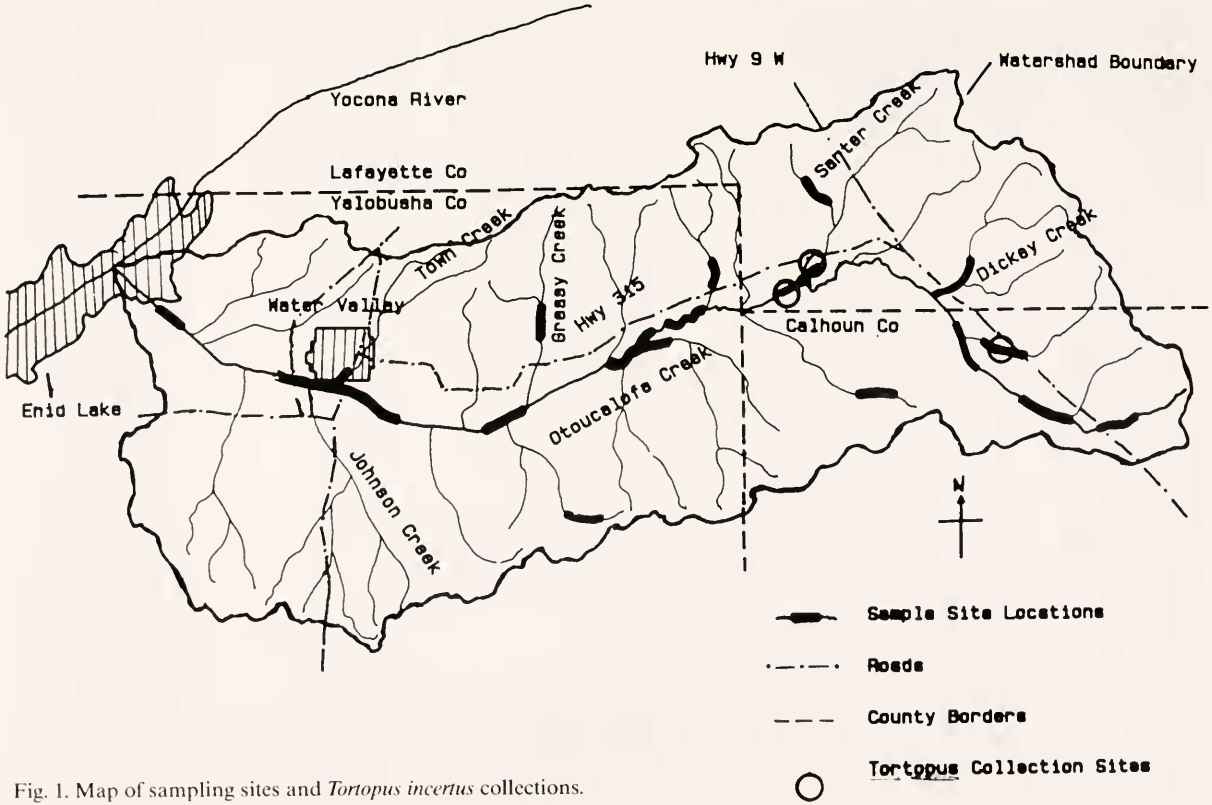

Fig. 1. Map of sampling sites and *Tortopus incertus* collections.

incertus habitat. Average ammonia concentrations of 0.147 mg/L was over 7 times higher on Otoucalofa Creek than the published average of 0.02 mg/L ammonia (Hart and Fuller, 1974) for *T. incertus*. Tsui and Peters (1975) in a study of embryonic development of *T. incertus* found that most rapid morphogensis and earliest hatches occurred at temperatures around 19.5°C. Otoucalofa Creek averaged 18.6°C with a range of 1.2 to 26.9°C.

Densities of *T. incertus* were calculated to be 89 organisms per m^2 on Otoucalofa Creek based on 18 individuals recovered from 9 samples (Table 2). This density is considerably less than 3125 organisms per m^2 reported from the Savannah river by Scott *et al.* (1959). Scott *et al.* (1959) suggested that *T. incertus* may move from burrow to burrow as water level changes. Our study supports this hypothesis since there are numerous exposed burrows above the water level. The locations on Otoucalofa Creek where hard clay substrates are found are usually high energy areas where dramatic erosional processes have scoured down to clay sills, thus suggesting that *T. incertus* nymphs are tolerant of adverse conditions found in small high energy streams and that they colonize hard clay habitats as they become available.

Although it is true that rivers vary in physical and chemical characteristics over an annual cycle, the magnitude of variation is not as great as in small streams specifically in regard to small storm flow events and low flow depths. Depths at the collection sites on Otoucalofa Creek have varied from 5 cm to 3.5 m within a 12 hour period and total solids have been measured that were 1439 mg/L greater than the yearly average of 48 mg/L. Vertical river banks accumulate some silt; however, some clay bottomed areas of Otoucalofa creek are covered with as much as 1 m of sand during 24 hour storms.

T. incertus nymphs have been found in large rivers at depths greater than 2 ft (60.9 cm) and are usually associated with vertical channel banks (Scott *et al.* 1959). In Otoucalofa Creek nymphs were collected predominantly on the horizontal portions of the stream bed at a maximum depth of 5 cm.

CONCLUSIONS

T. incertus is typically considered an inhabitant of clay banks of large rivers but the discovery of *T. incertus* colonies in a small highly erosive stream suggests that the size of the stream is less important than the hard clay substrate needed for burrow construction. Greater instability of physical characteristics of small streams when compared to rivers also indicates the tolerance of *T. incertus* to a wide range of environmental

Table 1. Water quality parameters downstream of *Tortopus incertus* collection sites.

Parameter	Annual Mean	Range	Units
Temperature	18.6	(1.2 - 26.9)	°C
Conductivity	44	(32 - 58)	umhos/cm^2
Dissolved Oxygen	9.7	(7.6 - 12.1)	mg/L
pH	6.4	(5.4 - 7.4)	
Total Solids	133	(54 - 1886)	mg/L
Dissolved Solids	49	(38 - 63)	mg/L
Suspended Solids	85	(0 - 1845)	mg/L
Filterable Ortho Phosphorus	0.01	(0 - 0.30)	mg/L
Total Ortho Phosphorus	0.02	(0.01 - 0.41)	mg/L
Total Hydrolyzable Phosphorus	0.06	(0.01 - 0.52)	mg/L
Total Phosphorus	0.07	(0.02 - 0.62)	mg/L
Nitrate Nitrogen	0.07	(0.01 - 0.80)	mg/L
Ammonia Nitrogen	0.15	(0.01 - 2.65)	mg/L

Table 2. Colony size, sample number, numbers of individuals collected and density estimates for *Tortopus incertus* collected from Otoucalofa Creek, Mississippi.

Site	Colony* Size	Sample Number	Individuals Collected	Density Nos./m^2
1	15 m^2	1	4	177.7
1	15 m^2	2	2	88.8
1	15 m^2	3	1	44.4
1	15 m^2	4	1	44.4
2	5 m^2	1	2	88.8
2	5 m^2	2	4	177.7
2	5 m^2	3	1	177.7
3	1.5 m^2	1	3	133.3
3	1.5 m^2	2	0	0.0
Total		9	18	
Mean				88.8

*Areas of colonization were determined by measuring inundated hard clay surface with visible burrows. These areas change in size as water levels vary seasonally as indicated by the number of "dry" burrows exposed on the bank.

conditions. As suggested by Scott *et al.* (1959), our study showed that *T. incertus* may drift or migrate to more suitable habitat when conditions deteriorate. Water quality parameters measured at collection sites were found to cover a broader spectrum of physical and chemical conditions than have been previously reported (Hart and Fuller, 1974). These conditions, unlike fluctuating water levels, are inescapable via migration or drift. *T. incertus* may have been missed in earlier collections from small streams because clay substrates that are necessary for burrow construction occur infrequently in many streams and are difficult to sample.

LITERATURE CITED

Beckett, D.C., C.R. Bingham, and L.G. Sanders. 1983. Benthic macroinvertebrates of selected habitats of the Lower Mississippi River. J. Freshw. Ecol. 2:247-261).

Edmunds, G.F., Jr. 1984. Ephemeroptera. In, An Introduction to the Aquatic Insects of North America, 2nd Ed. R.W. Merritt and K.W. Cummins, ed. Kendall Hunt Pub. Co. Dubuque, Iowa. 94-125 pp.

Edmunds, G.F., Jr. S.L. Jensen, and L. Berner. 1976. The Mayflies of North and Central America. Univ. Minnesota Press, Minneapolis, MN. 330 pp.

Hart, C.W., Jr. and S.L.H. Fuller. 1974. Pollution Ecology of Freshwater IOnvertebrates. Academic Press. New York, NY. 389 pp.

McCafferty, W.P. 1975. The burrowing mayflies (Ephemeroptera: Ephemeroidea) of the United States. Trans. Am. Ent. Soc. 101:447-504.

Scott, D.C., L. Berner, and A. Hirch. 1959. The nymph of the mayfly genus *Tortopus* (Ephemeroptera: Polymitarcidae). Ann. Ent. Soc. Am. 52:205-213.

Tsui, P.T.P. and W.L. Peters. 1975. Embrionic development, early morphology, and behavior of *Tortopus incertus* (Ephemeroptera: Polymitarcidae). The Florida Entomolgist. 57(4)349-356.

Unzicher, J.D. and P.H. Carlson. 1982. Ephemeroptera. In, Aquatic insects and oligochaetes of North and South Carolina. A.R. Brigham, W.U. Brigham and A. Gnilka, ed. Midwest Aquatic Enterprises, Mahomet, Ill. 822 pp.